

ICESat (GLAS) Science Processing Software Document Series

Volume #

**GLAS Standard Data Products
Specification - Level 2
Version 4.0**

**Peggy L. Jester/Raytheon ITSS
Observational Science Branch
Laboratory for Hydrospheric Processes
NASA/GSFC Wallops Flight Facility
Wallops Island, Virginia 23337**

**Jeffrey Lee/Raytheon ITSS
Observational Science Branch
Laboratory for Hydrospheric Processes
NASA/GSFC Wallops Flight Facility
Wallops Island, Virginia 23337**

November 2001

ICESat Contacts:

**H. Jay Zwally, ICESat Project Scientist
*NASA Goddard Space Flight Center
Greenbelt, Maryland 20771***

**Bob E. Schutz, GLAS Science Team Leader
*University of Texas Center for Space Research
Austin, Texas 78759-5321***

**David W. Hancock III, Science Software Development Leader
*NASA/GSFC Wallops Flight Facility
Wallops Island, Virginia 23337***



Foreword

This document defines the Level Two GLAS standard data products. This Standard Data Products Specification is developed under the structure of the NASA STD-2100-91, a NASA standard defining a four-volume set of documents to cover an entire software life cycle. Under this standard a section of any volume may, if necessary, be rolled out to its own separate document. This document is a roll out of the GLAS ESDIS Software Detailed Design Specification under the Product Specification Volume.

The GEOSCIENCE LASER ALTIMETER SYSTEM (GLAS) is a part of the EOS program. This laser altimetry mission will be carried on the spacecraft designated EOS ICESat (Ice, Cloud and Land Elevation Satellite). The GLAS laser is a frequency-doubled, cavity-pumped, solid state Nd:YAG laser.

This document addresses the data flow, interfaces, record and data formats associated with the GLAS Level 2 standard data products. The term “standard data products” refers to those EOS instrument data products listed in the Earth Science Data and Information System (ESDIS) Project data base that are routinely generated within the EOSDIS Distributed Active Archive Center (DAAC) or Science Computing Facilities (SCFs). Each data product has a unique Product Identification code assigned by the EOS Senior Project Scientist.

The Level 2 Standard Data Products specifically include those derived geophysical data values (i.e., ice sheet elevation, cloud height, vegetation height, etc.). Additionally, the appropriate correction elements used to transform the Level 1A and Level 1B Data Products into Level 2 Data Products are included. The data are packaged with time tags, precision orbit location coordinates, and data quality and usage flags.

This document was prepared by the Observational Science Branch at NASA GSFC/WFF, Wallops Island, VA, in support of B. E. Schutz, GLAS Science Team Leader for the GLAS Investigation. This work was performed under the direction of David W. Hancock, III, who may be contacted at (757) 824-1238, hancock@osb.wff.nasa.gov (e-mail), or (757) 824-1036 (FAX).

Table of Contents

Foreword	iii
Table of Contents	v
List of Figures	vii
List of Tables	ix
Section 1	Introduction
1.1	Identification of Document 1-1
1.2	Scope of Document 1-1
1.3	Purpose and Objectives of Document. 1-1
1.4	Document Organization 1-1
1.5	Document Status and Schedule 1-1
Section 2	Related Documentation
2.1	Parent Documents. 2-1
2.2	Applicable Documents. 2-1
2.3	Information Documents 2-2
Section 3	Purpose and Description of the Data Products
3.1	Purpose of the Data Products. 3-1
3.2	Description of the Data Product. 3-1
Section 4	Environment
4.1	Hardware Characteristics and Limitations. 4-1
4.2	Data Product Medium and Characteristics. 4-1
4.3	Protocol and Conventions 4-1
4.4	Failure Protection, Detection, and Recovery Features 4-2
Section 5	Data Flow Characteristics
5.1	Volume, Size, and Frequency Estimates 5-1
5.2	Data Transfer and Transmission 5-1
5.3	Timing and Sequencing Characteristics 5-2
5.4	Recipients and Utilization 5-2
5.5	Access. 5-2
Section 6	Data Products Definitions
6.1	Data Products Structure. 6-1
6.2	Labeling and Identification. 6-1
6.3	Data Products Substructure Descriptions. 6-1
6.4	Detailed Data Descriptions. 6-3

**Appendix A Standard Label
 Contents & Description**

Appendix B Level 2 Data Product Formats

B.1 Record Formats.	B-1
Abbreviations & Acronyms.	AB-1
Glossary.	GL-1

List of Figures

Figure 3-1	GLAS Level 2 Products Within The Data Product Hierarchy . . .	3-3
Figure 4-1	Data Representation	4-2

List of Tables

Table 3-1	GLAS Level 2 Standard Data Products	3-1
Table 5-1	GLAS Level 2 Data Product Daily Storage Burden	5-1
Table 6-1	GLAS File Naming Keys	6-1
Table 6-2	GLAS Data Product Description Fields	6-2
Table 6-3	GLAS Detailed Data Description Fields	6-3
Table A-1	Common Product Header Elements	A-1

Section 1

Introduction

1.1 Identification of Document

This document is identified as the GLAS Level 2 Standard Data Products Specification. The unique document identification number within the GLAS Standard Data Software documentation numbering scheme is GLAS-DPS-2641. Progressive editions of this document will be uniquely identified by the cover and page date marks.

1.2 Scope of Document

This document addresses the purpose, usage, and description of the GLAS Level 2 Standard Data Products. The intended audience for this document is the GLAS Science and Instrument Teams, the ESDIS Project and related focus teams, the community of EOS data users and investigators, and the GLAS Standard Data Software Development Team. This document will not address the procedures for obtaining the GLAS Level 2 Standard Data Products from the EOSDIS DAAC.

1.3 Purpose and Objectives of Document

The purpose of the GLAS Level 2 Standard Data Products Specification is to provide a high-level descriptive document for the data products. This document describes the purpose, usage, content, and format of the GLAS Level 2 Data Products. It describes the representation and definition of the GLAS data elements constituting the data product. It further describes the structure, physical storage, organization, and access characteristics of the GLAS Level 2 Data Products. The document additionally describes file transfer methods to support product access, the data flow associated with the data product, and the data storage and generation characteristics of the data product.

1.4 Document Organization

This document outline is assembled in a form similar to those presented in the NASA Software Engineering Program [Applicable Document 2.3a].

1.5 Document Status and Schedule

This document will be updated and released as required.

1.5.1 Document Change History

Document Name: GLAS Standard Data Products Specification - Level 2		
Version Number	Date	Nature of Change
Preliminary	December 31, 1995	Original Version
Version 1.2	March 1998	Text, Figures, and Tables updated for Level 2 data updates, for the change to GLAS standard data product generation being performed at the GLAS SCF, and change of the spacecraft name to ICESAT.
Version 2.0	January 1999	Updates to the data product contents.
Version 3.0	November 2000	Updated Data Product Contents coincident with the GLAS Science Algorithm Software V1 release.
Version 4.0	November 2001	Updated Data Product Contents coincident with the GLAS Science Algorithm Software V2 release.

Related Documentation

2.1 Parent Documents

The GLAS Level 2 Standard Data Products Specification is considered a "roll-out" from the Product Specification as the parent document or volume. Specific topics pertaining to data descriptions are located in the External Interface sections under the Detailed Design document template.

This document is subordinate to any top-level mission or instrument management plan documents, and as such, recognizes these documents as external parent documents in lineage. The recognized external EOSDIS and GLAS parent documents superior to the GLAS Level 2 Standard Data Products Specification are listed below.

- a) *NASA Earth Observing System Geoscience Laser Altimeter System GLAS Science Requirements Document*, Version 2.01, October 1997, Center for Space Research, University of Texas at Austin.
- b) *GLAS Science Software Management Plan*, NASA/TM-1999-208641/Ver.3/Vol.1, August 1998, NASA Goddard Space Flight Center, Wallops Flight Facility.

2.2 Applicable Documents

The following documents are applicable to, or contain policies or references pertinent to the contents of the GLAS Level 2 Standard Data Products Specification.

- a) *Data Production Software, Data Management, and Flight Operations Working Agreement for GLAS*, TBD, NASA Goddard Space Flight Center.
- b) *Atmospheric Delay Correction to GLAS Laser Altimeter Ranges*, Algorithm Theoretical Basis Document, Version 0.3, December 1996, Massachusetts Institute of Technology.
- c) *Algorithm Theoretical Basis Document for the GLAS Atmospheric Channel Observations*, Version 0 (Preliminary), December 1995, Goddard Space Flight Center.
- d) *Geoscience Laser Altimeter System: Surface Roughness of Ice Sheets*, Algorithm Theoretical Basis Document, Version 0.3, December 1996, University of Wisconsin.
- e) *Determination of Sea Ice Surface Roughness from Laser Altimeter Waveform*, Algorithm Theoretical Basis Document, Version 0 (Preliminary), December 1995, The Ohio State University.
- f) *Laser Footprint Location and Surface Profiles*, Algorithm Theoretical Basis Document, Version 0 (Preliminary), December 1996, Center for Space Research, The University of Texas at Austin.

- g) *Precision Orbit Determination (POD)*, Algorithm Theoretical Basis Document, Version 0.1, December 1996, Center for Space Research, The University of Texas at Austin.
- h) *Precision Attitude Determination (PAD)*, Algorithm Theoretical Basis Document, December 1996, Center for Space Research, The University of Texas at Austin.
- i) *GLAS Atmospheric Data Products*, Algorithm Theoretical Basis Document, Version 4.0, July 2000, Goddard Space Flight Center.

2.3 Information Documents

The following documents are provided as sources of information that provide background or supplemental information that may clarify or amplify material in the GLAS Level 2 Standard Data Products Specification.

- a) *NASA Software Documentation Standard Software Engineering Program*, NASA, NASA-STD-21000-91, July 29, 1991.
- b) *The Geoscience Laser Altimetry/Ranging System*, IEEE Transactions on Geoscience and Remote Sensing, Vol. GE-25, No. 5, September 1987.
- c) *EOS Altimetry/GLAS Phase-A Study*, NASA Goddard Space Flight Center, November 1995.
- d) *Memorandum: GLAS Data Products*, Center for Space Research, University of Texas at Austin, December 23, 1993.
- e) *GLAS Science Computing Facility (SCF) Plan*, NASA Goddard Space Flight Center, Wallops Flight Facility, October 1997.

Purpose and Description of the Data Products

3.1 Purpose of the Data Products

The purpose of the GLAS Level 2 Standard Data Products is to provide time-ordered, processed GLAS data, acceptable for science applications. This GLAS derived data consists of calibrated laser altimeter data supplemented with precision orbit determination, earth-location and precision attitude data from the ancillary data sources. The GLAS Level 2 Standard Data Products are intended for use by the GLAS Science Team, and by the EOSDIS data user community.

3.2 Description of the Data Product

Table 3-1 identifies the Level 2 Data Products and shows the composition of each. The data products are integer-binary format files containing fixed-length records of data. Each data record consists of several data elements. An element is either an Item or an Array of Items. The elements are measurements and associated correction values obtained from specific GLAS science algorithm sets. The data products will be formatted in scaled integer binary format with both attached and unattached metadata containing identification, processing history, and data descriptive information.

Table 3-1 GLAS Level 2 Standard Data Products

Product ID (Identification)	Product Name	Product Level
GLA08	Boundary Layer and Elevated Aerosol Layer Heights File	2
GLA09	Cloud Height for Multiple Layers File	2
GLA10	Aerosol Vertical Structure File	2
GLA11	Thin Cloud/Aerosol Optical Depth File	2
GLA12	Ice Sheet Products File	2
GLA13	Sea Ice Products File	2
GLA14	Land Products File	2
GLA15	Ocean Products File	2

n/a - Not applicable

The GLAS Level 2 Standard Data Products are generated as product aggregates or files (i.e., nominally a pass, a half orbit) of GLAS derived geophysical data. The data parameters represent derived geophysical data and associated correction values obtained from specific GLAS science algorithms. These data parameter groups include time tags, data use and quality flags, and precision orbit location data. In

addition to the data products, metadata including identification, processing history, and data content descriptive information is produced for archival.

The GLAS Level 2 Standard Data Products are produced by the GLAS science data processing software which is based on the GLAS Algorithm Theoretical Basis Documents [Applicable Documents 2.2b - 2.2h]. These data products are produced by processing the GLAS Level 1 Data Products to form the Level 2 data. Figure 3-1 illustrates the source data products being processed to generate the Level 2 Data Products.

The specific details of the data product structure, content, format, and data element details will be presented in Section 6. Data sizing and burden, and physical media details are provided in Section 5.

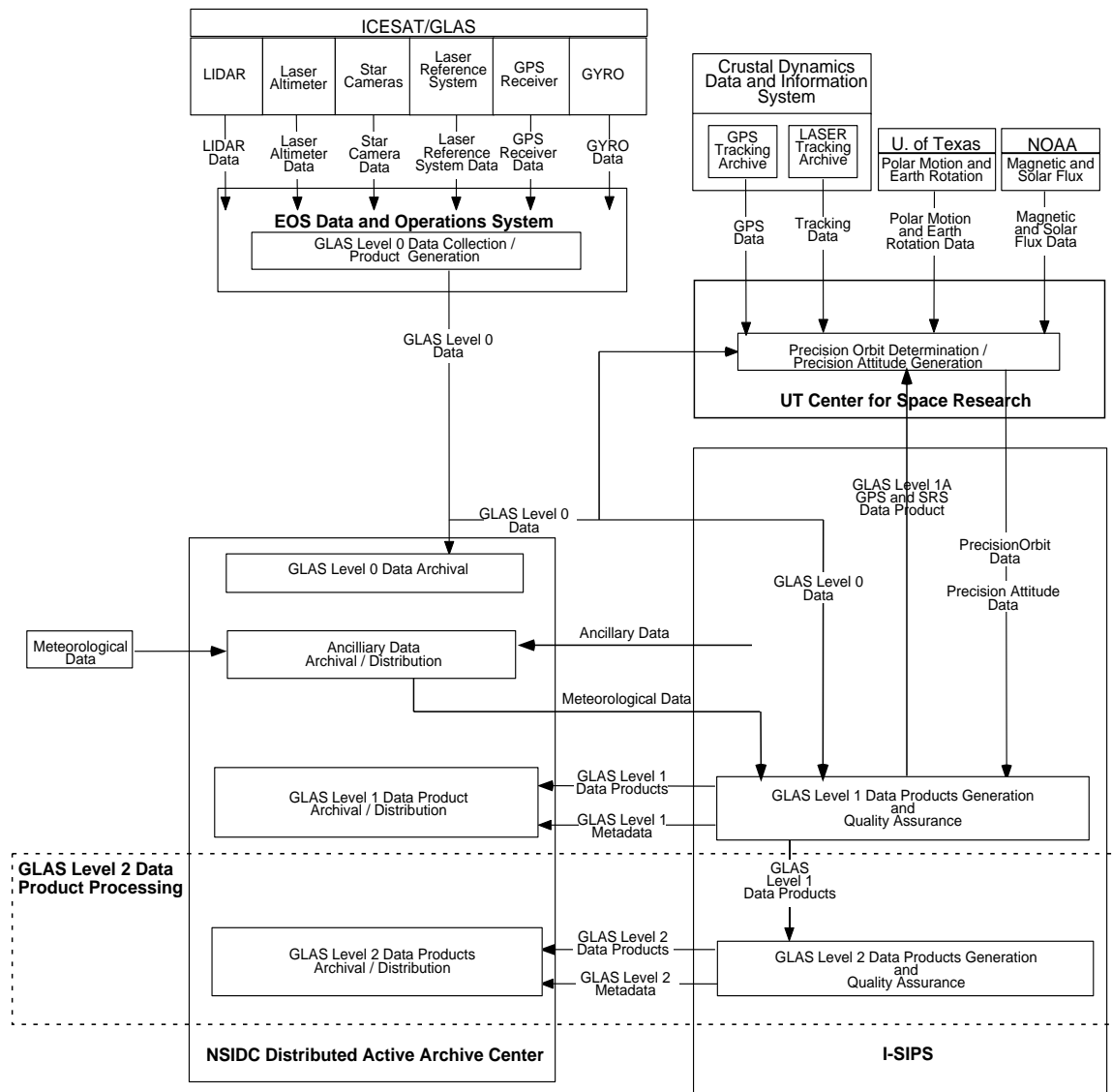


Figure 3-1 GLAS Level 2 Products Within The Data Product Hierarchy

Section 4

Environment

4.1 Hardware Characteristics and Limitations

The GLAS Level 2 Standard Data Products will be generated on the UNIX host processors within the I-SIPS. The input GLAS Level 1 Data Products and ancillary data reside in the I-SIPS storage facilities. Newly-generated Level 2 Data Products are accessed for quality assurance (QA) monitoring through the I-SIPS.

The I-SIPS consists of distributed UNIX operating system-based computers operating under the standard UNIX environment that support the GLAS Science Team operations including the quality monitoring. The GLAS Level 2 Data Products and their metadata (including the QA monitoring data) are delivered to the EOSDIS DAAC archive. The Level 2 metadata (associated data description and support information) are stored in the EOSDIS DAAC to facilitate EOS client inquiry and retrieval activities. The distribution management function of the EOSDIS DAAC allows clients to perform direct search and access of the Level 2 data or to request preparation of Level 2 Data Products.

4.2 Data Product Medium and Characteristics

The Data Products will be archived within the EOSDIS DAAC. The storage system will contain not only the Level 2 Data Products, but will also contain data descriptions and data advertisements (i.e., textual descriptive and abstract information also called metadata). The Level 2 Data Products and their metadata will be part of the Earth Sciences Data Types collection.

The Earth Science data are implemented in the current EOSDIS system through a hierarchical storage manager interface. Physical media supported by the storage system interface will include the disk storage subsystems, magnetic or optical media subsystems, and tiered archive robotics storage subsystems. EOSDIS clients can directly access the GLAS Level 2 data from the DAAC and can copy the data products to their host processors across the EOSDIS Networks.

The Level 2 Data Products will be available to the GLAS Science Team through the GLAS SCF. See Information Document 2.3e for a detailed description of the GLAS SCF.

4.3 Protocol and Conventions

Specific protocols and convention applying to the GLAS SCF will be specified in the SCF Plan [Information Document 2.3e]. When interfacing to the EOSDIS DAAC, the I-SIPS will comply with procedures, conventions, and protocols as defined by the EOSDIS.

Data definition terminology specific to the GLAS Level 2 Data Products and this document is presented in the Glossary at the end of this document. Figure 4-1 “Data Representation” depicts a schematic of the standard data representations used in GLAS Level 2 Data Products. These data structures will be used in the Section 6.0 generic data description and in the Appendix C detailed data description of the GLAS Level 2 Data Product contents.

Data Types, Sizes, and Representations

Conventions: byte 0 is the most significant byte (MSB)
bit 0 is the least significant bit (lsb)
S = the sign bit

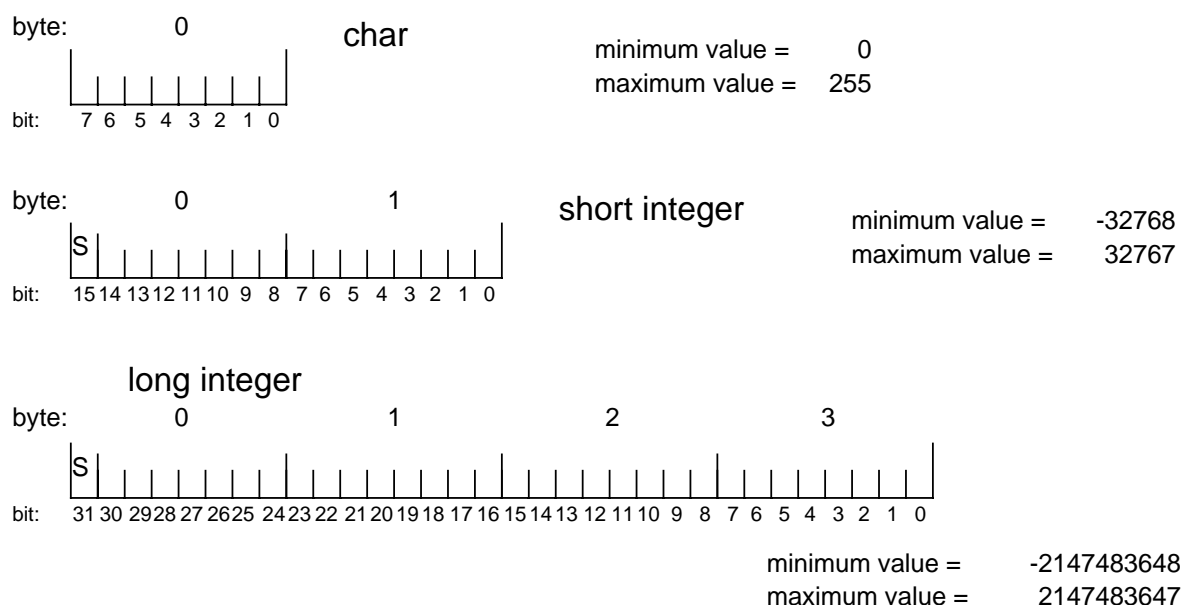


Figure 4-1 Data Representation

4.4 Failure Protection, Detection, and Recovery Features

The team supporting operations at the I-SIPS will be responsible for failure protection, detection, and recovery of the generated GLAS Level 2 Data Products stored on the I-SIPS. Initial GLAS Level 2 Data Products error detection is performed during product generation as part of the product and processing quality assurance activity. The GLAS Level 2 Data Products will be “backed up” under the routine operational functions performed at the I-SIPS. In the event of failure or error detection in the active working or archive storage, recovery would be performed from backup media or from the EOSDIS DAAC archive.

The EOSDIS will be responsible for failure protection, detection, and recovery of the GLAS Level 2 Data Products archived at the EOSDIS DAAC.

Data Flow Characteristics

5.1 Volume, Size, and Frequency Estimates

The expected daily data burdens for the GLAS Level 2 Standard Data Products are listed in Table 5-1 “GLAS Level 2 Data Product Daily Storage Burden”. These estimates are based on the following EOS ICESat (Ice, Cloud, and Land Elevation Satellite) operational assumptions. The spacecraft will orbit the Earth at an inclination of 94 degrees and a nominal altitude of 600 kilometers in a circular orbit. The orbit (groundtrack) repeat cycle is one-half year based on a frozen orbit. The EOS ICESat orbit period will be approximately 100 minutes, with a pass period duration of approximately 50 minutes.

Table 5-1 GLAS Level 2 Data Product Daily Storage Burden

Product ID	Volume (MBytes per Day)
GLA08	7
GLA09	82
GLA10	289
GLA11	13
GLA12	103
GLA13	106
GLA14	177
GLA15	113

n/a - Not applicable

The daily volumes shown in Table 5-1 are assuming 24 hours of global coverage for each product. However, the contents of the GLA12, GLA13, GLA14, and GLA15 products will be edited based on location. Therefore the actual daily volume of these products may vary from what is shown in the table.

5.2 Data Transfer and Transmission

The GLAS Science Team will have access to the GLAS Level 2 Data Products through the GLAS SCF using TCP/IP and standard UNIX command operations. GLAS Level 2 Data Products generated within the I-SIPS will be transferred to the DAAC through the EOS Science Network or off-line via storage media.

Data access procedures to retrieve GLAS Level 2 Standard Data Products from the DAAC will be provided by the EOSDIS DAAC.

5.3 Timing and Sequencing Characteristics

The GLAS Level 2 Standard Data Products are generated as product files consisting of processed GLAS Level 1A and Level 1B Standard Data Products data. The basic aggregation of the GLAS Level 2 Data Products is the descriptive information in the header records and GLAS Data Elements in the data record. All data records within the GLAS Level 2 Data Products will be in ascending time order based on the height vector or aerosol measurement time tag. All parameters contained within the record are synchronous. The GLAS instrument and the EOS ICESat spacecraft are expected to operate for at least three years with a goal of five years.

5.4 Recipients and Utilization

The initial recipients of the GLAS Level 2 Data Products will be the GLAS Science Team and the EOSDIS. At the I-SIPS, the GLAS Level 2 Data Products will be used to produce the metadata quantifying and qualifying the products for EOS community usage. The GLAS Science Team will use the Level 2 Data Products for analysis and research. The subsequent recipients for the GLAS Level 2 Data Products are the scientific, governmental, and educational community sectors which will obtain the data products from the EOSDIS DAAC.

5.5 Access

The GLAS Level 2 Data Products are available to the GLAS Science Team from the GLAS SCF. Access to the GLAS SCF is controlled by the GLAS Science Team.

While EOS is intended to be a globally available and utilized mission program, access to the data is still operated under a security and integrity program to protect the data and data system resources from unauthorized or destructive use. Procedures for data access are provided by the EOSDIS DAAC.

Section 6

Data Products Definitions

6.1 Data Products Structure

The GLAS Level 2 Standard Data Products will be generated as scaled integer binary files. Each file will include appropriate header, labelling, and metadata information.

6.2 Labeling and Identification

Each of the GLAS Level 2 Data Products is uniquely identified by a GLAS standard file name. The form of this file name is

GLAxx_mmm_pr_ccc_tttt_s_nn_ff.dat

Specific elements within the file name are described in Table 6-1.

Table 6-1 GLAS File Naming Keys

Key	Description
xx	The GLAS Product ID (01-15)
mmm	release number for process that created the produce (CCB assigned-combination of software and data)
p	repeat ground track phase
r	reference orbit number
ccc	cycle of reference orbit for this phase
tttt	track within reference orbit
s	segment of orbit
nn	granule version number (the number of times this granule is created for a specific release)
ff	file type (numerical, CCB assigned for multiple files as needed for data of same time period for a specific GLAxx,.i.e. multi-file granule)

The structure and contents of the GLAS Level 2 Data Product headers and labels are contained in Appendix A.

6.3 Data Products Substructure Descriptions

Full data product descriptions are provided online in a hyperlinked format at the WFF GLAS website. The URL for product descriptions is:

http://glas.wff.nasa.gov/v2_products/

Table 6-2 lists the fields shown in each data product description entry.

Table 6-2 GLAS Data Product Description Fields

Field	Description
ID	GLAS File ID (GLA01, GLA02, etc).
Name	Descriptive name.
Product Type	Product Type (Standard Ancillary).
Product Level	Product Level (L0,L1A,L1B,L2,L3).
Science Discipline	Primary associated science discipline.
Investigator	Primary investigator.
Temporal Resolution	Nominal time span, in seconds, of each record of data within a file.
Temporal Coverage	Nominal time span, in minutes, of data contained within a file.
Horiz Res Coverage	Horizontal coverage, in meters, over Earth's surface for each instrument measurement.
Vert Res Coverage	Vertical coverage, in meters, over the Earth's surface for each instrument measurement.
Instrument Name	Source instrument for the file (GLAS).
Archive Site	Location at which this file will be permanently archived.
File Disposition	Usage indicator with the following definitions: Archive - a file that is permanently archived after it is created. Interim - a file that is created for use by a subsequent process, but is not archived. Permanent - a file that is assumed to be kept in the processing environment for repeated access by one or more processes. Temporary - a file that is created by a process during its execution and is then deleted after termination. Transfer to SCF - similar to an Interim file, except the process that uses it is at an SCF.
Root/External Flag	A flag signifying whether this file is: 0 : neither of the following. 1 : the head-of-chain (Level 0 data) of an instrument's data stream. 2 : a file from an external source.
Filespec	Standard GSAS naming convention specification for the file.
Source	A flag giving source data system of this file.
Frequency (per day)	Number of times processing PGE is executed.
Files per Granule	Number of physical files per each granule.
CPU (min)	Number of processing minutes required to produce a granule of this data.

Table 6-2 GLAS Data Product Description Fields (Continued)

Field	Description
MB per Day	Estimated amount of this data processed each data.
Record Size (bytes, 0=variable)	Size, in bytes, of a single record of data. 0 indicates a variable sized record.
Granule Size (MB)	Size, in megabytes, of a granule.
Granules per Day	Number of granules normally processed per day.
Revs per Granule	Number of earth revolutions contained in one granule.
Description	Text description.
Comment	Text comments.

6.4 Detailed Data Descriptions

Detailed data descriptions are provided at the website listed above. These descriptions provide details for each value within a product file. Table 6-3 lists the fields shown in each detailed data description entry.

Table 6-3 GLAS Detailed Data Description Fields

Field	Description
ID	Unique identifying name of the product variable.
Name	Descriptive name of the product variable.
Prod Variable Type	Product (Unscaled) Variable Type. i1b = Integer, 1 byte i2b = Integer, 2 bytes i4b = Integer, 4 bytes r4b = Real, 4 bytes r8b = Real, 8 bytes etc...
Unsigned	Flag indicating if the variable is unsigned.
Prod Dimension 1	1st array dimension of the product variable (if applicable).
Prod Dimension 2	2nd array dimension of the product variable (if applicable).
Prod Minimum Variable	Minimum value supported in product variable.
Prod Maximum Variable	Maximum value supported in product variable.
Is a Flag	Flag indicating if the variable is a flag.

Table 6-3 GLAS Detailed Data Description Fields (Continued)

Field	Description
Invalid Value	<p>Indicates what identifies the filed as being invalid.</p> <p>None = variable cannot be invalid. gd_invalid_xxx = datatype-specific value which indicates the variable is not valid. [variable name] = name of the flag to check in order to determine validity of the variable.</p>
Prod Units	Units of the product variable.
Alg Variable Name	Unique identifying name of the algorithm variable.
Alg Variable Type	<p>Algorithm (Scaled) Variable Type.</p> <p>i1b = Integer, 1 byte i2b = Integer, 2 bytes i4b = Integer, 4 bytes r4b = Real, 4 bytes r8b = Real, 8 bytes etc...</p>
Alg Dimension 1	1st array dimension of the algorithm variable (if applicable).
Alg Dimension 2	2nd array dimension of the algorithm variable (if applicable).
Alg Units	Units of the algorithm variable.
Alg Scale	Scale factor to use when converting between product and algorithm variables. (algorithm = product * scale)
Special Conversions	Flag identifying if a special conversion routine is required when converting to/from product and algorithm values.
A2P Conversion	Name of special routine which converts from Algorithm to Product values.
P2A Conversion	Name of special routine which converts from Product to Algorithm values.
Description	Text description (flags contain hyperlinks to descriptive PDF files).
Comment	Text comments.

Appendix A

Level 2 Data Products

Standard Label

Contents & Description

GLAS Products begin with ASCII header records containing information regarding the processing which created the Product and the data contained within. These header records are exactly the same size as a Product data record and contain ASCII information in a slightly modified KEYWORD=VALUE format. In order to conserve space on the product, the header entries are not delimited by the record length, but by a semi-colon (;) and linefeed (ASCII 10).

By design, the first two header entries are the record length and number of header records. This allows product readers to verify the record length and jump directly to the first data record, if necessary. Most of the remaining information within the headers is directly applicable to the generation of metadata files for EOS ingest.

The following common fields are defined for GLAS Product Headers:

Table A-1 Common Product Header Elements

Keyword	Content Description
Recl	Record length in bytes.
Numhead	Number of header records preceeding product data records.
ReprocessingPlanned	
ReprocessingActual	
LocalGranuleID	Filename of this granule.
SizeMBECSDDataGranule	
ProductionDateTime	Processing data and time.
LocalVersionID	Version ID number.
SP_ICE_Path_No	
SP_ICE_GLAS_StartBlock	
SP_ICE_GLAS_EndBlock	
ShortName	Short name of product (corresponds to GLAS filetype).
VersionID	Version number.
RangeBeginningTime	Time of first data record.
RangeEndingTime	Time of last data record.

Table A-1 Common Product Header Elements (Continued)

Keyword	Content Description
RangeBeginningDate	Date of first data record.
RangeEndingDate	Date of Last data record.
PGEVersion	Version number of generating PGE.
AutomaticQualityFlagExpln	Automatic Quality flag explanation.
OperationalQualityFlagExpl	Operational Quality flag explanation.
ScienceQualityFlagExplana	Science Quality flag explanation.
Instance	Instance number.
cycle	Cycle number
time_between_contiguous_r	Time between contiguous records.
Range_Bias	Range bias value.
Timing_Drift	Timing drift value.
InstrumentShortName	Instrument name (GLAS).
PlatformShortName	Platform name (Icesat).
SensorShortName	Sensor name (LaserAlt).
EquatorCrossingLongitude	Longitude of equator crossing.
EquatorCrossingTime	Time of equator crossing.
EquatorCrossingDate	Date of equator crossing.
InputPointer	Name of each input product file used to created this product (one instances of this keyword appears in the product header record for each input product file used in creation of this product).
AncillaryInputPointer	Name of each input ancillary file used to created this product (one instances of this keyword appears in the product header record for each input product file used in creation of this product).
AncillaryInputType	File type of each AncillaryInputPointer value. (one instance for each instance of AncillaryInputPointer keyword.) File type corresponds to GLAS file types.
ReferenceOrbit	Reference orbit number.
laser_number	Laser identification number.
laser_number_beg_date.tim	Date/Time specified laser was first used.
detector_number	Detector identification number.
detector_number_beg_dat	Date/Time specified detector was first used

Table A-1 Common Product Header Elements (Continued)

Keyword	Content Description
oscillator number	Oscillator identification number.
oscillator_number_beg_da	Date/Time specified oscillator was first used
Photon Counters in use	Photon detector identification number.
Photon Counter_beg_date.t	Date/Time specified photon detector was first used

Appendix B

Level 2 Data Product Formats

B.1 Record Formats

B.1.1 Guidelines

The GLAS Data Product record formats were developed under the following guidelines:

- 1) Record size a multiple of 8.
- 2) Start elements on a 4 byte boundary; where not possible use pads or group smaller elements together to get to 4 byte boundary. Pad and move elements so that arrays start on 4 byte boundaries.
- 3) The output structures to build files should be grouped in descending size order, therefore group elements on file logically and in descending size order.
- 4) Data that occurs occasionally in the file should be put in the header. Specifically, the orbit number and instrument state are changing at a much lower rate than the record rate on the files, therefore the orbit numbers and instrument states encompassed by a file will be put in the header. These elements will not be shown in the record format. Other data in the same category will be put in the header.
- 5) Add spares.

B.1.2 GLA08

Each record contains 20 seconds of data. Empty aerosol or planetary boundary layers will contain fill data.

B.1.3 GLA09

Each record contains 4 seconds of data. Empty cloud layers will contain fill data.

B.1.4 GLA10

Each record contains 4 seconds of data.

B.1.5 GLA11

Each record contains 4 seconds of data.

B.1.6 GLA12

Each record contains 1 second of data.

B.1.7 GLA13

Each record contains 1 second of data.

B.1.8 GLA14

Each record contains 1 second of data.

B.1.9 GLA15

Each record contains 1 second of data.

Abbreviations & Acronyms

DAAC	Distributed Active Archive Center
ECS	EOSDIS Core System
EDOS	EOS Data and Operations System
EOC	EOS Operating Center
EOS	Earth Observing System
EOSDIS	Earth Observing System Data and Information System
GDS	GLAS Ground Data System
GLAS	Geoscience Laser Altimeter System instrument or investigation
GPS	Global Positioning System
GSFC	NASA Goddard Space Flight Center at Greenbelt, Maryland
GSFC/WFF	NASA Goddard Space Flight Center/Wallops Flight Facility at Wallops Island, Virginia
HDF	Hierarchical Data Format
ICESat	<u>I</u> ce, <u>C</u> loud, and Land <u>E</u> levation <u>S</u> atellite
ID	Identification
IEEE	Institute for Electronics and Electrical Engineering
IST	GLAS Instrument Support Terminal
LASER	Light Amplification by Stimulated Emission of Radiation
LIDAR	Light Detection and Ranging
N/A	Not (/) Applicable
NASA	National Aeronautics and Space Administration
NOAA	National Oceanic and Atmospheric Administration
POD	Precision Orbit Determination
QA	Quality Assurance
SCF	Science Computing Facility
SDPS	Science Data Processing Segment
TBD	to be determined, to be done, or to be developed
UNIX	the operating system jointly developed by the AT&T Bell Laboratories and the University of California-Berkeley System Division
WFF	Wallops Flight Facility

Glossary

aggregate	A collection, assemblage, or grouping of distinct data parts together to make a whole. It is generally used to indicate the grouping of GLAS data items, arrays, elements, and EOS parameters into a data record. For example, the collection of Level 1B EOS Data Parameters gathered to form a one-second Level 1B data record. It could be used to represent groupings of various GLAS data entities such as data items aggregated as an array, data items and arrays aggregated into a GLAS Data Element, GLAS Data Elements aggregated as an EOS Data Parameter, or EOS Data Parameters aggregated into a Data Product record.
array	An ordered arrangement of homogenous data items that may either be synchronous or asynchronous. An array of data items usually implies the ability to access individual data items or members of the array by an index. An array of GLAS data items might represent the three coordinates of a georeference location, a collection of values at a rate, or a collection of values describing an altimeter waveform.
file	A collection of data stored as records and terminated by a physical or logical end-of-file (EOF) marker. The term usually applies to the collection within a storage device or storage media such as a disk file or a tape file.
header	A text and/or binary label or information record, record set, or block, prefacing a data record, record set, or a file. A header usually contains identifying or descriptive information, and may sometimes be embedded within a record rather than attached as a prefix.
item	Specifically, a data item. A discrete, non-decomposable unit of data, usually a single word or value in a data record, or a single value from a data array. The representation of a single GLAS data value within a data array or a GLAS Data Element.
label	The text and/or binary information records, record set, block, header, or headers prefacing a data file or linked to a data file sufficient to form a labeled data product. A label may consist of a single header as well as multiple headers and markers depending on the defining authority.
Level 0	The level designation applied to an EOS data product that consists of raw instrument data, recorded at the original resolution, in time order, with any duplicate or redundant data packets removed.
Level 1A	The level designation applied to an EOS data product that consists of reconstructed, unprocessed Level 0 instrument data, recorded at the full resolution with time referenced data records, in time order. The data are annotated with ancillary information including radiometric and geometric calibration coefficients, and georeferencing parameter data (i.e., ephemeris data). The included, computed coefficients and parameter data have not however been applied to correct the Level 0 instrument data contents.
Level 1B	The level designation applied to an EOS data product that consists of Level 1A data that have been radiometrically corrected, processed from raw data into sensor data units, and have been geolocated according to applied georeferencing data.

Level 2	The level designation applied to an EOS data product that consists of derived geophysical data values, recorded at the same resolution, time order, and georeference location as the Level 1A or Level 1B data.
Level 3	The level designation applied to an EOS data product that consists of geophysical data values derived from Level 1 or Level 2 data, recorded at a temporally or spatially resampled resolution.
Level 4	The level designation applied to an EOS data product that consists of data from modeled output or resultant analysis of lower level data that are not directly derived by the GLAS instrument and supplemental sensors.
metadata	The textual information supplied as supplemental, descriptive information to a data product. It may consist of fixed or variable length records of ASCII data describing files, records, parameters, elements, items, formats, etc., that may serve as catalog, data base, keyword/value, header, or label data. This data may be parsable and searchable by some tool or utility program.
orbit revolution	The passage of time and spacecraft travel signifying a complete journey around a celestial or terrestrial body. For GLAS and the EOS ICESat spacecraft each orbit revolution count starts at the time when the spacecraft is on the equator traveling toward the North Pole, continues through the equator crossing as the spacecraft ground track moves toward the South Pole, and terminates when the spacecraft has reached the equator moving northward from the South Polar region.
parameter	Specifically, an EOS Data Parameter. This is a defining, controlling, or constraining data unit associated with a EOS science community approved algorithm. It is identified by an EOS Parameter Number and Parameter Name. An EOS Data Parameter within the GLAS Data Product is composed of one or more GLAS Data Elements
pass	A sub-segment of an orbit, it may consist of the ascending or descending portion of an orbit (e.g., a descending pass would consist of the ground track segment beginning with the northernmost point of travel through the following southernmost point of travel), or the segment above or below the equator (e.g., either the northern or southern hemisphere portion of the ground track on any orbit).
product	Specifically, the Data Product or the EOS Data Product. This is implicitly the labeled data product or the data product as produced by software on the DAAC or SCF. A GLAS data product refers to the data file or record collection either prefaced with a product label or standard formatted data label or linked to a product label or standard formatted data label file. Loosely used, it may indicate the entire set of product files contained in a data repository.
record	A specific organization or aggregate of data items. It represents the collection of EOS Data Parameters within a given time interval, such as a one-second data record. It is the first level decomposition of a product file.
Standard Data Product	Specifically, a GLAS Standard Data Product. It represents an EOS ICESat/ GLAS Data Product produced on the DAAC or on the SCF. It is routinely produced and is intended to be archived in the EOSDIS data repository for EOS user community-wide access and retrieval.
variable	Usually a reference in a computer program to a storage location.
